



Ministry of
Transportation and
Communications

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**A REVIEW OF MTC
CONCRETE COMPRESSIVE
STRENGTH DATA FOR 1986**

**MATERIALS INFORMATION
ENGINEERING MATERIALS OFFICE**

**A REVIEW OF M.T.C. CONCRETE COMPRESSIVE
STRENGTH DATA FOR 1986**

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ENGINEERING MATERIALS OFFICE
CONCRETE SECTION**

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INTRODUCTION

Most concrete placed on Ministry contracts must meet the requirements of OPSS 1350 in the Ontario Provincial Standards Specifications. One of the requirements of acceptance is based on the results of 28-day compressive strength tests as specified in Section 1350.08.01.05 of the specifications. Copies of the 28-day compressive strength tests from throughout the Province are forwarded to the Concrete Section of the Engineering Materials Office in Downsview. These results are placed in a microcomputer for the purpose of reviewing the results and to provide contract, regional and provincial summaries. The test results are not used by the Concrete Section for acceptance or rejection purposes.

The purpose of this report is to provide a summary and review of 28-day compressive strength test results from the 1986 contracts throughout Ontario involving concrete work. The summary includes test results of all concrete classes from 15 MPa to 40 MPa including latex modified concrete. Not included in the report are results on concrete placed on maintenance and municipal contracts or tremie concrete. Only the test results from concrete placed in 1986 are included in the report.

RESULTS

A test is defined as the average of two standard 150 mm x 300 mm cylinders as stated in OPSS 1350. For this report the term "pass" and "fail" have been used. The "pass" term indicates that the results of a single 28-day compressive test (average of 2 standard cylinders) is greater than or equal to the specified strength. The "fail" term indicates that the results of a single 28-day compressive strength test is less than the specified strength.

Table 2.1 shows the total number of tests performed in each of the five regions as well as the percentages of tests that passed:

TABLE 2.1: SUMMARY OF TESTS BY REGION

<u>REGION</u>	<u>NUMBER OF TESTS</u>	<u>% PASS</u>
Central	1455	98.1
Southwestern	398	95.2
Eastern	664	95.1
Northwestern	249	93.3
Northern	306	89.7
All Regions	3072	93.3

In Table 2.2 the tests in each region are broken down by concrete with no slag cement, concrete containing slag cement and latex modified concrete.

Figures 2.1 to 2.9 provide a graphical summary of the test results by concrete class and type. The figures show the mean and the standard deviation of all test results by contract for each concrete class in the five regions. Actual contract numbers in each region have been replaced with series of numbers beginning at 1. Contracts that contained less than two test results for a given concrete class were not shown in these figures. Appendix A contains the statistics in all test results throughout the province in tabular form.

Figure 2.1 summarizes test results for 20 MPa class concrete containing no slag cement. Good compressive strengths were achieved with this class of concrete.

REGION	15 MPa		15 MPa SLAG		20 MPa		20 MPa SLAG		25 MPa		25 MPa SLAG	
	#TESTS	% PASS	#TESTS	% PASS	#TESTS	% PASS	#TESTS	% PASS	#TESTS	% PASS	#TESTS	% PASS
CENTRAL REGION	8	100	1	100	125	100	161	100	104	98.1	84	100
SOUTHWESTERN REGION	-	-	-	-	102	99.0	-	-	117	98.3	-	-
EASTERN REGION	-	-	-	-	105	100	-	-	99	98.0	-	-
NORTHWESTERN REGION	-	-	-	-	12	100	3	100	5	100	-	-
NORTHERN REGION	1	100	-	-	50	100	-	-	17	100	-	-
ALL REGIONS	9	100	1	100	394	100	164	100	342	98.2	84	100

REGION	30 MPa		30 MPa SLAG		30 MPa LATEX		35 MPa		35 MPa SLAG		40 MPa	
	#TESTS	% PASS	#TESTS	% PASS	#TESTS	% PASS	#TESTS	% PASS	#TESTS	% PASS	#TESTS	% PASS
CENTRAL REGION	515	91.8	196	96.4	29	100	161	95.7	68	95.6	3	100
SOUTHWESTERN REGION	157	92.4	-	-	8	100	14	71.4	-	-	-	-
EASTERN REGION	460	87.2	-	-	-	-	-	-	-	-	-	-
NORTHWESTERN REGION	213	91.5	-	-	16	75.0	-	-	-	-	-	-
NORTHERN REGION	223	84.3	-	-	2	100	13	53.8	-	-	-	-
ALL REGIONS	1568	89.4	196	96.4	55	92.7	188	91.0	68	95.6	3	100

TABLE 2.2 SUMMARY OF TESTS BY REGION (NON-SLAG CEMENT, SLAG CEMENT, LATEX MODIFIED CONCRETE)

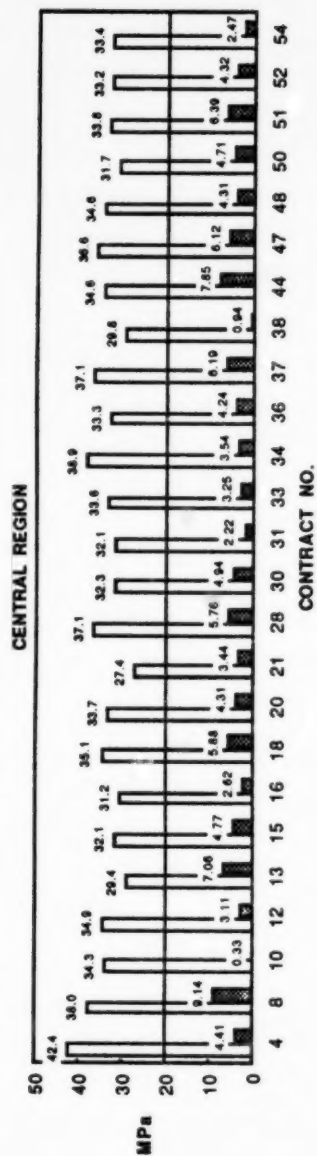


FIGURE 2.1 SUMMARY OF TESTS BY CONTRACT- 20 MPa NON-SLAG CEMENT

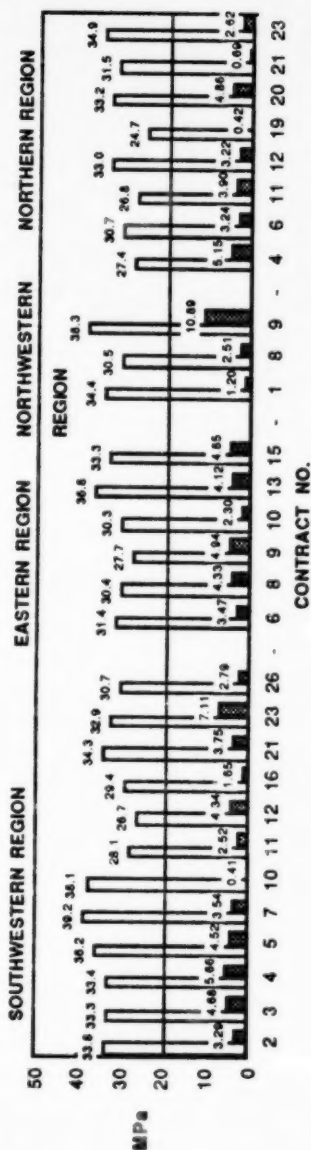


FIGURE 2.1 SUMMARY OF TESTS BY CONTRACT- 20 MPa NON-SLAG CEMENT

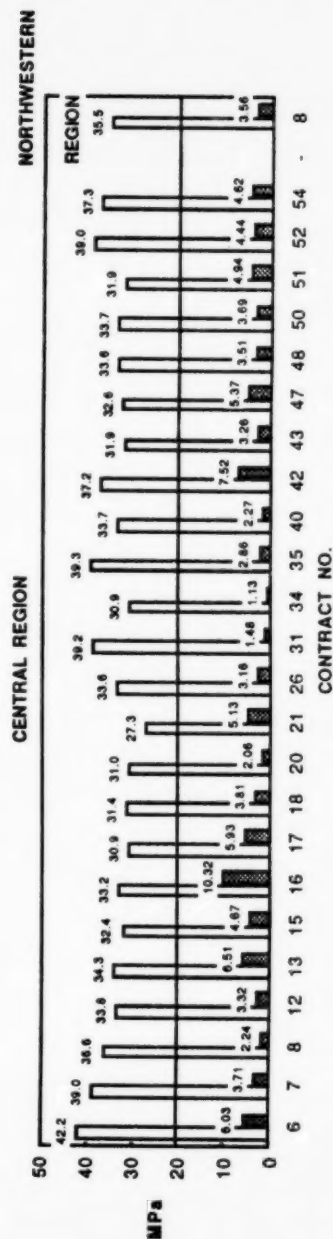


FIGURE 2.2 SUMMARY OF TESTS BY CONTRACT- 20 MPa SLAG CEMENT



Figure 2.2 presents the test results for 20 MPa class concrete containing slag cement. This class of concrete was used only in Central Region and Northwestern Region. In both regions no difficulties were encountered in obtaining good compressive strengths.

Figure 2.3 contains the summary of test results for 25 MPa class concrete containing no slag cement. No problems were encountered in achieving good compressive strengths with this class of concrete.

The test results for 25 MPa class concrete containing slag cement are present in Figure 2.4. This class of concrete was used only in Central Region. No difficulties have been experienced with this type of concrete.

Figure 2.5 summarizes test results for 30 MPa class concrete containing no slag cement. All regions experienced difficulties with this class of concrete. In Central Region 42 tests out of 515 tests failed to meet the specified strength. In Northwestern Region 18 tests failed to meet the required strength out of 213 tests. Eastern Region had 59 tests fail out of 460 tests. Southwestern Region had 12 failures out of 157 tests while Northern Region had 35 failures out of 223 tests.

Figure 2.6 presents the test results for 30 MPa class concrete containing slag cement. This class of concrete was used only in Central Region. Out of 196 tests, 7 tests failed to meet the specified strength requirement.

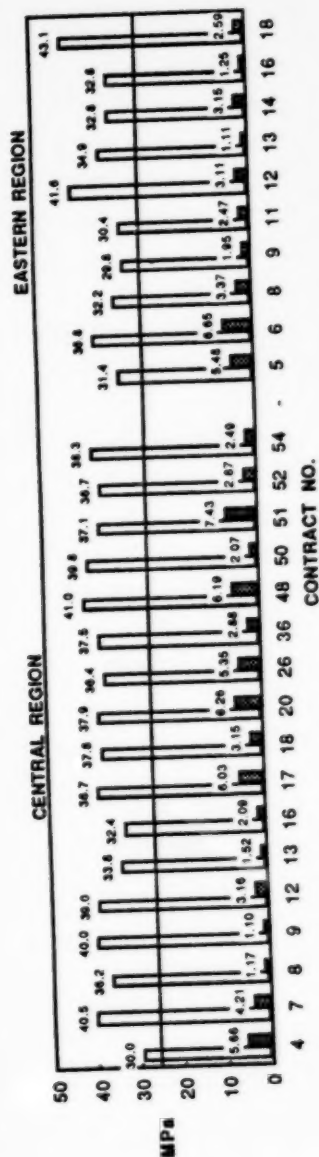


FIGURE 2.3 SUMMARY OF TESTS BY CONTRACT - 25 MPa NON-SLAG CEMENT

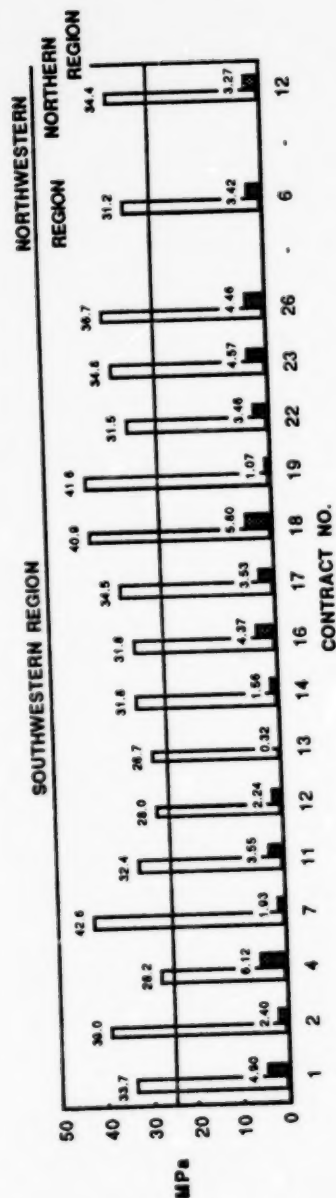


FIGURE 2.3 SUMMARY OF TESTS BY CONTRACT - 25 MPa NON-SLAG CEMENT

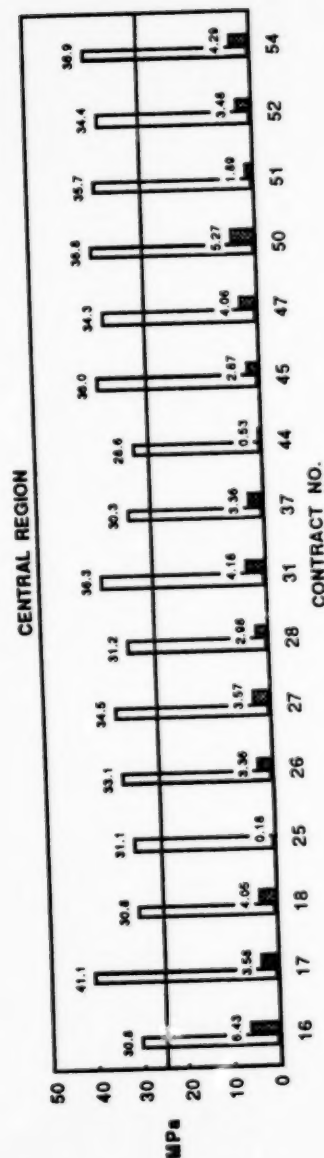
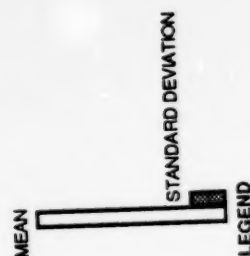
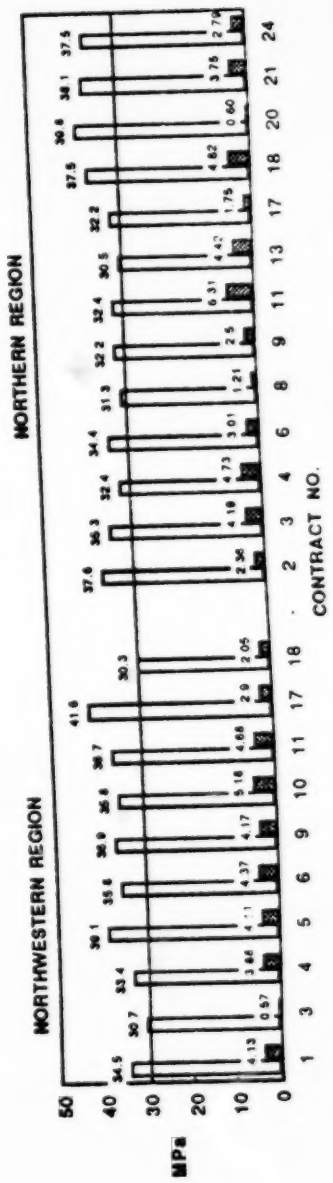
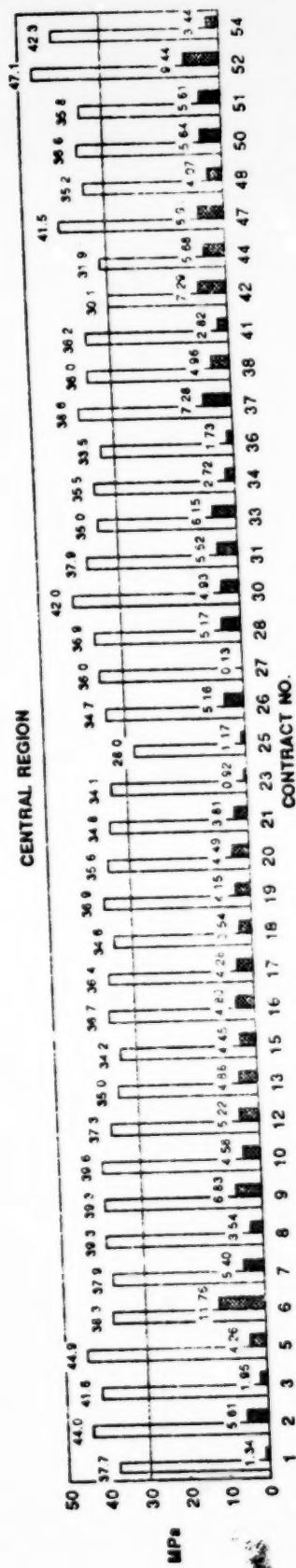
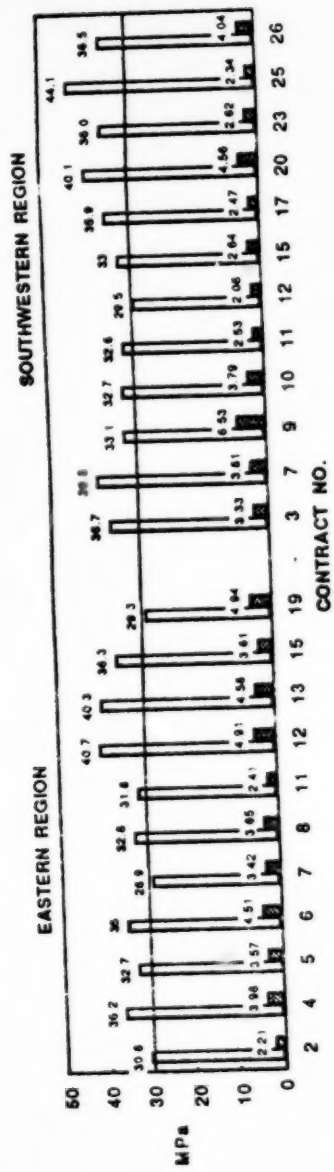


FIGURE 2.4 SUMMARY OF TESTS BY CONTRACT - 25 MPa SLAG CEMENT



NORTHERN REGION

FIGURE 2.5 SUMMARY OF TESTS BY CONTRACT- 30 MPa NON-SLAG CEMENT

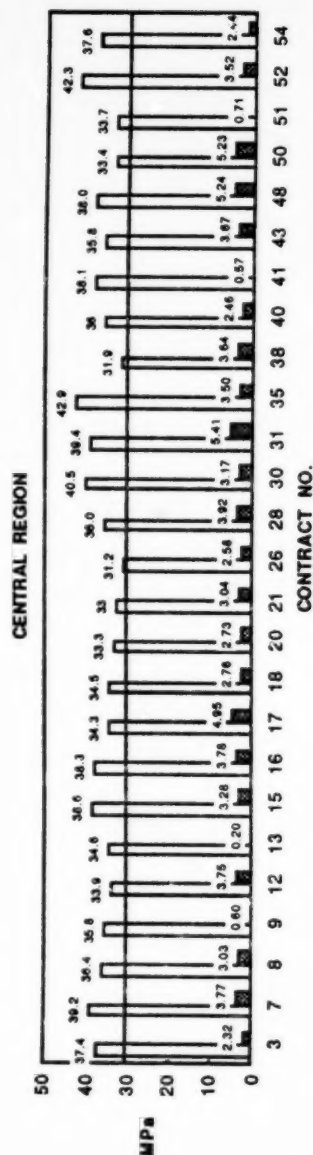


FIGURE 2.6 SUMMARY OF TESTS BY CONTRACT - 30 MPa SLAG CEMENT

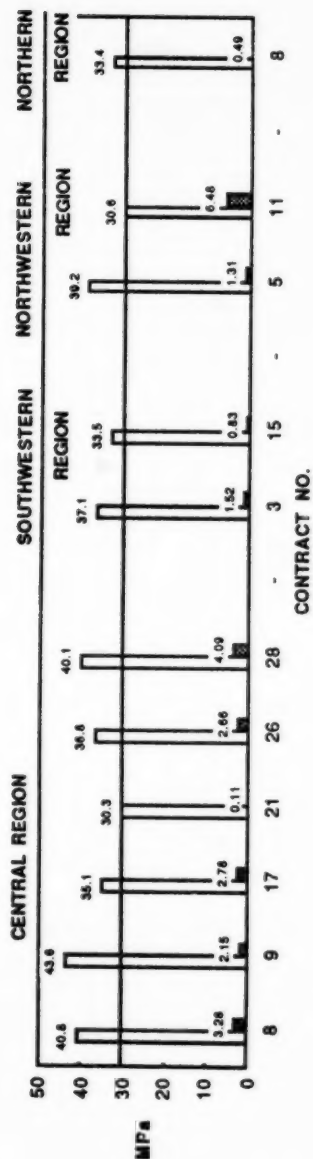


FIGURE 2.7 SUMMARY OF TESTS BY CONTRACT - 30 MPa LATEX MODIFIED CONCRETE

MEAN
STANDARD DEVIATION
LEGEND

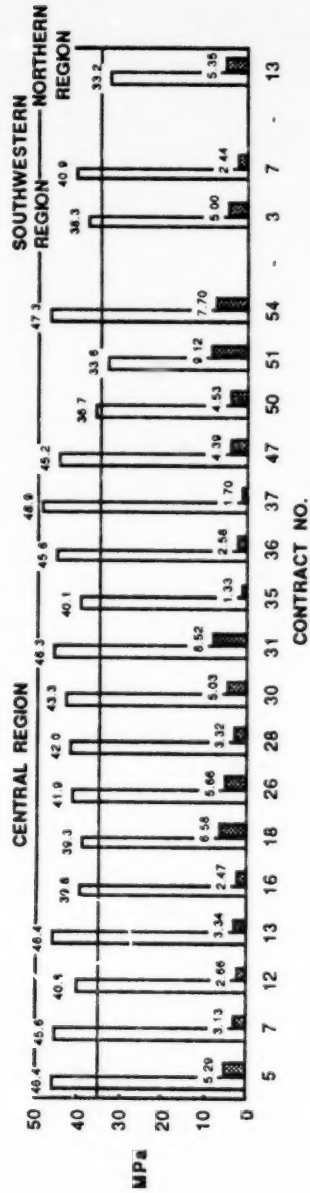


FIGURE 2.8 SUMMARY OF TESTS BY CONTRACT- 35 MPa NON-SLAG CEMENT

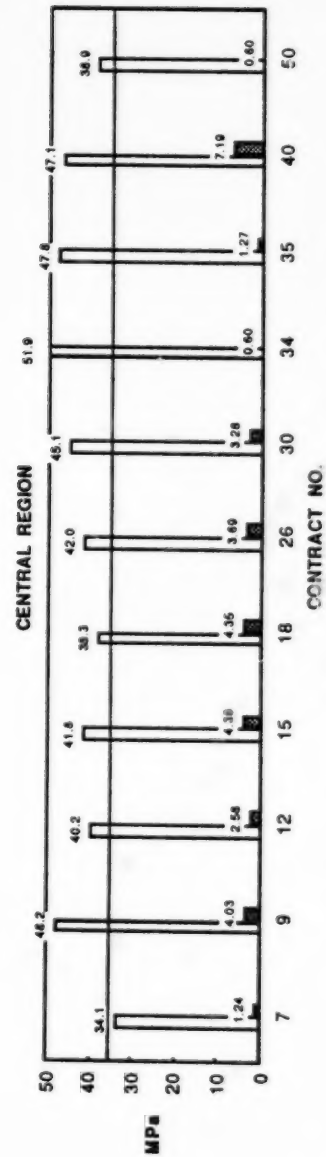


FIGURE 2.9 SUMMARY OF TESTS BY CONTRACT- 35 MPa SLAG CEMENT



Figure 2.7 contains the summary of test results on 30 MPa latex modified concrete. This class of concrete was used in all regions except in the Eastern Region. Problems were encountered in Northwestern Region where 4 tests out of 16 tests failed to meet the specified strength requirements. In the other regions no problems were encountered.

The test results for 35 MPa class concrete containing no slag cement are present in figure 2.8. This class of concrete was used in Central, Southwestern and Northern Regions. Some difficulties were encountered in all regions. In Central Region 7 tests out of 161 tests failed to meet the required strength. Southwestern Region had 2 test failures out of a total of 14 tests while Northern Region had 6 tests fail the specified strength requirement out of 13 tests.

Figure 2.9 summarizes test results from 35 MPa class concrete containing slag cement. This class of concrete was used only in Central Region. Out of 68 tests only 3 tests failed to meet the required strength.

SUMMARY

- a) Good compressive strengths were achieved with the 15 MPa, 20 MPa and 25 MPa class concrete with or without slag cement.
- b) All regions experienced low compressive strengths in 30 MPa class concrete.

- c) Good compressive strengths were achieved with latex modified concrete in all regions except Northwestern Region.
- d) Central Region experienced minor low compressive strengths in 35 MPa class concrete with or without slag cement. Southwestern Region and Northern Region experienced low compressive strengths in 35 MPa class concrete containing no slag cement.
- e) 3,072 tests were carried out in 1986 of which 93.3 percent were greater or equal to the required strength.

APPENDIX A

SUMMARY OF 28-DAY COMPRESSIVE STRENGTH TEST RESULTS

CENTRAL REGION

CONTRACT	18 MPa	18 MPa BLAD	20 MPa	20 MPa BLAD	28 MPa	28 MPa BLAD	30 MPa	30 MPa BLAD	30 MPa LATER MOD	30 MPa	30 MPa BLAD	30 MPa	30 MPa BLAD	40 MPa
1	TESTS	MEAN ST. DEV.	TESTS	MEAN ST. DEV.	TESTS	MEAN ST. DEV.	TESTS	MEAN ST. DEV.	TESTS	MEAN ST. DEV.	TESTS	MEAN ST. DEV.	TESTS	MEAN ST. DEV.
1														
2														
3														
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54														

NORTHWESTERN REGION

CONTRACT	20 MPa	20 MPa SLAG	25 MPa	25 MPa SLAG	30 MPa	30 MPa SLAG	30 MPa LATEX MOD	35 MPa	35 MPa SLAG
	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV
1	3	34.4	1.20		28	34.5	4.13		
2					1	30.3			
3					2	30.7	0.57		
4					24	33.4	3.68		
5					20	39.1	4.11		
6	1	32.7		4	31.2	3.42	32	35.8	4.37
7	1	34.3					1	32.1	
8	4	30.5	2.51				22	36.9	4.17
9	2	38.3	10.89				12	35.8	5.18
10							62	36.7	4.68
11							1	38.2	
12							1	26.9	
13									
14	1	25.7							
15				1	38.2				
16									
17									
18									

NORTHERN REGION

CONTRACT	15 MPa	20 MPa	20 MPa SLAG	25 MPa	25 MPa SLAG	30 MPa	30 MPa SLAG	30 MPa LATEX MOD	35 MPa
	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV
1							1	30.0	
2							3	37.6	2.38
3							63	35.3	4.19
4				1	35.2		32	32.4	4.73
5							1	29.4	
6							13	34.4	3.01
7							7	31.3	1.21
8							8	32.2	2.50
9									
10									
11	1	23.9					28	32.4	6.31
12							22	30.5	4.42
13				16	34.4	3.27			
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									

SOUTHWESTERN REGION

CONTRACT	20 MPa			25 MPa			30 MPa			30 MPa FLY ASH			30 MPa LATEX MOO			35 MPa			35 MPa SLAG		
	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV
1																					
2	2	33.8	3.29	5	33.7	4.90															
3	37	33.3	4.68	11	39.0	2.40															
4	8	33.4	5.66	1	36.0																
5	4	36.2	4.52	9	28.2	6.12															
6																					
7	2	30.2	3.54	1	42.1																
8				3	42.6	1.93															
9																					
10	2	38.1	0.41	1	29.6																
11	14	28.1	2.52	7	32.4	3.55															
12	11	26.7	4.34	13	28.0	2.24															
13				2	28.7	0.32															
14				5	31.6	1.56															
15																					
16	8	28.4	1.85	5	31.8	4.37															
17	1	37.8		9	34.5	3.53															
18				2	40.9	5.80															
19				4	41.6	1.07															
20																					
21	11	34.3	3.75																		
22				4	31.5	3.48															
23	2	32.9	7.11	29	34.8	4.57															
24				1	29.5																
25																					
26	2	30.7	2.79	5	38.7	4.46															

EASTERN REGION

CONTRACT	20 MPa			25 MPa			30 MPa			30 MPa SLAG			30 MPa LATEX MOO			35 MPa			35 MPa SLAG		
	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV	TESTS	MEAN	ST DEV
1																					
2	1	31.3		1	30.0																
3																					
4	1	27.5		2	31.4	5.48															
5				4	36.8	6.65															
6	35	31.4	3.47																		
7																					
8	8	30.4	4.33	54	32.2	3.37															
9	3	27.7	4.94	6	29.8	1.95															
10	2	30.3	2.30																		
11				2	30.4	2.47															
12				7	41.6	3.11															
13	35	36.8	4.12	3	34.9	1.11															
14				12	32.8	3.15															
15	20	33.3	4.85																		
16				4	32.8	1.25															
17				3	43.1	2.59															
18				1	25.5																
19																					